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DIMENSIONS OF STEM AND LEAF FIBERS [1]

Robert E. Perdue, Jr. [2]

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1/ Supplementary table for: Fiber Dimensions of Nonwoody Plant Materials, by R. E. Perdue, Jr. and H. J. Nieschlag, Tappi 44(11): 776-784 (1961).

2/ Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture, Beltsville, Maryland.

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DIMENSIONS OF STEM AND LEAF FIBERS

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This compilation of data from the literature provided a basis for the report: Fiber Dimensions of Nonwoody Plant Materials, by R. E. Perdue, Jr. and H. J. Nieschlag, published in Tappi, volume 44, number 11, November 1961.

The accompanying tabulation, with certain exceptions, lists all available data on the dimensions of the ultimate fibers of nonwoody plant materials. Species for which only measurements of fiber diameter are available were excluded. The table does not include data for seed fiber such as Gossypium (cotton) or Asclepias (milkweed) or for woody plants except for those referring to the bast fibers of such species. Data on bast fibers of woody plants were included primarily to provide additional information for families which are poorly represented by data on the bast of nonwoody species. While bamboos are "woody" in the sense of the hardness of their tissues, they are structurally similar to the more typical grasses as are such other "woody" grasses as Arundo donax L. and Phragmites communis Trin.

The table shows, from left to right, the name of the plant species, a symbol designating the type of material examined, minimum, maximum, and average fiber lengths, minimum, maximum, and average fiber diameters, length: diameter ratio (L/D), appropriate remarks, and source of data.

The species are divided into the two primary groups: monocotyledons and dicotyledons. Within these two groups the plants are arranged alphabetically according to family, genus, and species, with the exception of the grasses in which the genera are arranged by tribes.

The names used in the table are those employed in the most recent floras covering the areas to which the plants are native. In cases in which the name given in a reference is a synonym, it follows the correct name parenthetically in the table. In most instances the original reference does not give the authority for the name used and it is frequently impossible to determine the correct name in cases in which several species have been described under the name used in the original reference.

The type of material from which the data for each sample were obtained is indicated in the second column, headed "Material Tested", by the following symbols:

Stem fibers

SBA bast-fiber samples extracted from annual or perennial herbs ("soft fibers")

SBB bast-fiber samples extracted from woody stems

SC the "woody core" of herbaceous stems (material remaining after removal of the bast)

SWA whole stems of nonwoody plants, both dicotyledons and monocotyledons (grass samples in many cases probably included more or less leaf material)

SWB whole stems of bamboos

Leaf fibers

LF samples of fiber extracted from leaves ("hard-fiber" - the structural elements of leaves)

LP petioles of leaves, primarily from species of palms

LW whole leaves

Minimum, maximum, and average fiber lengths are here rounded off to the first decimal place even though in the literature they were frequently given in hundredths or thousandths of a millimeter. Minimum, maximum, and average fiber diameters are given in thousandths of a millimeter.

The length: diameter ratios were calculated from the averages given in the table except where the source gave no average but did cite a length: diameter ratio or where the dimensions given here represent a series of analyses of a single species. In the latter case the length: diameter ratio is indicated as a range.

The numbers indicating the source of the data refer to items in the bibliography.

For the well-known plant sources of fiber such as flax (Linum usitatissimum L.), true hemp (Cannabis sativa L.), kenaf (Hibiscus cannabinus L.), etc., a large number of fiber analyses are available in the literature. Some are based on independent work, others are repetitions of analyses previously published. Some of the latter are erroneous as a result of typographical or other errors. In preparing the compilation, the following system was used: If all of the available analyses were essentially uniform, only a single representative analysis was incorporated in the table. Where considerable variation was involved, representative analyses were used to indicate minimum recorded average length, maximum recorded average length and, where practicable, a mean recorded average length. To cite every recorded analysis would greatly increase the length of the table without any real increase in its value; 20 or 30 analyses could be included for some plants.

DIMENSIONS OF STEM AND LEAF FIBERS

Species	Material Tested	Fiber Dimensions						L/D	Remarks	Ref.
		Length (mm.)			Diameter (mm.)					
		min.	max.	av.	min.	max.	av.			
Monocotyledoneae										
Amaryllidaceae										
Agave americana (A. karatto)	LF	1.5	4	2.5	0.020	0.032	0.024	104		164
A. cantala	LF	1.3	3.8	2.4	0.010	0.017	0.014	171	small fiber strand	9
	LF	1.7	5.7	3.0	0.015	0.025	0.018	167	large fiber strand	9
A. fourcroydes (A. rigida)	LF	1.3	2.2	1.9	0.014	0.021	0.018	106	small fiber strand	9
	LF	1.2	4.0	2.7	0.012	0.022	0.017	159	large fiber strand	9
A. lurida (A. mexicana)	LF	1.5	2							76
A. rumphii	LF	1.5	2.5							76
A. sisalana	LF	1.2	4.7	2.7	0.013	0.021	0.017	159		9
A. tequilana (A. azul)	LF	1.8	2.2							98
A. zapupe	LF	1.5	2.5	1.9	0.014	0.016	0.015	127	small fiber strand	9
	LF	1.5	3.8	2.5	0.011	0.022	0.016	156	large fiber strand	9
Furcraea gigantea	LF	1.4	4.3	2.9	0.017	0.031	0.025	116	small fiber strand	9
	LF	2.4	4.3	3.2	0.034	0.054	0.041	78	large fiber strand	9
F. hexapetala (F. cubensis)	LF	1.5	4							76
F. selloa var. marginata (F. lindeni)	LF	2.3	4.2							98
Araceae										
Montrichardia aculeata (Caladium aculeatum)	SWA	2	2.3	2.1	0.023	0.030	0.025	84		57
M. arborescens	SWA			2.0-2.4	0.020	0.030				165

M. linifera	SWA	0.3	3			0.020				158
Typhonodorum lindleyanum	LF			1.0-1.6			0.032			13
Bromeliaceae										
Aechmea magdalenae	LF	1.4	11.0	5.3	0.003	0.015	0.009	589		40
Ananas comosus (A. sativa, Ananassa sativa)	LF	3	9	5	0.004	0.008	0.006	833		164
Bromelia argentina	LF	1	3.5	2.3	0.005	0.018	0.012	192		5
B. fastuosa	LF	0.3	2.5	0.9						91
B. karatas	LF	2.5	10	5	0.020	0.032	0.024	208		164
B. pinguin	LF	0.8	2.5	2	0.008	0.016	0.013	154		164
	LF	0.8	9	4.0-5.0	0.006	0.011	0.007-0.009	563		161
Neoglaziovia variegata	LF			1.5			0.008-0.010	167		165
	LF			4.0			0.010	400		151
Tillandsia sp.	SWA	0.2	0.5		0.006	0.015				172
Cyperaceae										
Carex acutiformis	SWA			1.0			0.020	50		130
Cladium jamaicense (Schoenus mariscus)	SWA	1	2		0.008	0.010				165
Cyperus alopecuroides	SWA	0.4	3.7	0.7-1.5						102
C. auricomus	SWA			1.2			0.011	109		32
C. latifolius	SWA	2	2.5	2.3	0.010	0.015	0.013	177	fine fibers	56
	SWA	1.2	1.5	1.4			0.030	47	coarse fibers	56
C. longus	SWA	1	1.5		0.006	0.020				130
C. madagascariensis	SWA	3.5	4.5	4.0	0.010	0.020	0.015	267	fine fibers	56
	SWA	2	3	2.5			0.030	83	coarse fibers	56
C. papyrus	SWA	0.4	6.3	1.6	0.006	0.019	0.011	145		12
Eleocharis plantaginea	SWA			1.3			0.007	186		32
Pycreus mundtii	SWA			1.6			0.009	178		32

Scirpus californicus	SWA	0.4	1.5	0.9	0.006	0.013	0.009	100		49
S. grossus	SWA	0.6	1.5	1.1			0.013	85		66
S. lacustris	SWA	0.5	1.3		0.006	0.012				130
Gramineae: Bambuseae										
Arundinaria alpina	SWB	1.6	2.7	2.3			0.023	100		4
										103
Bambusa arundinaceae	SWB	0.7	4.1	2.7	0.016	0.055	0.030	90		37
(Dendrocalamus arundinacea)	SWB	0.6	3.8	2.4	0.008	0.034	0.024	100		132
B. hoffi	SWB	0.8	5.1	2.2	0.006	0.031	0.015	147		113
B. longispiculata	SWB	0.3	4.1	1.4	0.002	0.021	0.009	156	base of culm	70
	SWB	0.3	4.5	1.6	0.003	0.021	0.008	200	upper section of culm	70
B. multiplex	SWB	0.5	3.3	1.6					immature stems	156
(B. nana)	SWB	0.5	3.7	1.9					mature stems	156
B. oldhami (Sinocalamus oldhami)	SWB	1.0	1.9	1.5	0.009	0.014	0.012	125		153
B. polymorpha	SWB	0.6	2.9	2.5	0.009	0.036	0.027	93		132
	SWB	1.0	5.8	3.2						16
B. spinosa	SWB	0.8	3.3	1.8			0.008	225		135
(B. blumeana, B. lumampao)	SWB	1.2	4.1	2.6	0.005	0.028	0.016	163		163
B. stenostachya (B. stenostachia)	SWB	1.1	1.8	1.5	0.008	0.016	0.012	125		136
										153
B. tulda	SWB	0.3	4.7	1.9	0.008	0.014	0.011	173	base of culm	70
	SWB	0.3	3.7	1.3	0.003	0.027	0.009	144	upper section of culm	70
	SWB	0.7	4.0	2.6	0.009	0.036	0.027	96		132
	SWB	1.0	5.0	3.0						16
B. tuldoides	SWB	0.4	4.4	1.7	0.004	0.031	0.010	170	base of culm	70
	SWB	0.4	4.7	1.7	0.003	0.017	0.009	189	upper section of culm	70
B. vulgaris	SWB	0.3	6.8	2.2	0.003	0.033	0.009	244		70
	SWB	0.9	6.5	3.8	0.007	0.050	0.018	211		113
B. vulgaris var. "stricta" (var. striata?)	SWB	1.0	5.4	2.7	0.006	0.027	0.015	180		114

Cephalostachyum pergracile	SWB	0.6	3.9	2.3	0.007	0.027	0.020	115		132
Dendrocalamus aspera (Gigantochloa aspera)	SWB			3.8			0.019	200		154
D. hamiltonii	SWB	1.5	6.8	3.4						16
D. latiflorus (Sinocalamus latiflorus)	SWB	1.1	1.7	1.4	0.010	0.013	0.012	117		153
D. longispathus	SWB	0.9	4.8	2.5	0.006	0.030	0.016	156		114
	SWB	1.0	5.5	3.5						16
D. merrillianus	SWB			2.2			0.014	157		154
D. strictus	SWB	0.6	4.2	2.4	0.006	0.035	0.020	120		37
	SWB	1.2	6.1	3.3	0.009	0.036	0.018	183		114
Gigantochloa apus	SWB	0.8	5.4	2.2	0.009	0.032	0.015	147		114
	SWB	1.6	4.6	2.7	0.008	0.024	0.014	193		75
G. aspera	SWB	0.9	5.5	3	0.008	0.050	0.026	115		113
G. atter	SWB	0.9	5.7	3.1	0.009	0.030	0.017	182		114
G. verticillata	SWB	0.8	6.2	3.2	0.008	0.029	0.014	228		114
G. wrayi	SWB	1.4	3.6	2.4						105
Guadua angustifolia	SWB	0.4	4.0	1.6	0.006	0.027	0.013	123	base of culm	70
	SWB	0.3	4.0	1.6	0.007	0.015	0.010	160	upper section of culm	70
Melocanna baccifera (M. bambusoides)	SWB	1.0	4.8	2.7						16
	SWB	0.8	2.9	2.2	0.007	0.022	0.018	122		132
Oxytenanthera abyssinica	SWB	1.1	4.8	2.3	0.008	0.037	0.018	128		147
O. nigrociliata	SWB	1.0	6.0	3.6						16
Ochlandra ridleyi	SWB	1.0	4.2	2.3						105
O. travancorica	SWB	0.9	5.5	2.5	0.004	0.032	0.017	147		114
	SWB	1.0	9.0	4.0						16
Phyllostachys arcana	SWB	0.3	3.8	1.4	0.005	0.026	0.012	117	base of culm	70
	SWB	0.2	4.3	1.6	0.003	0.030	0.011	145	upper section of culm	70
P. aurea	SWB	0.3	2.7	1.2	0.004	0.021	0.008	150	upper section of culm	70
	SWB	0.5	4.4	1.7	0.004	0.023	0.010	170	middle section of culm	70
	SWB	0.4	4.4	1.8	0.004	0.027	0.013	138	base of culm	70
P. aureosulcata	SWB	0.5	2.9	1.3	0.004	0.015	0.009	144		70
P. bambusoides	SWB	0.2	4.6	0.8-1.8	0.003	0.030	0.008-0.017	72-173	range of 10 samples	70
		0.2	1.3	0.6	0.010	0.035	0.021	29	nodal partition	153
	SWB	1.3	1.8	1.6	0.012	0.014	0.013	123		

P. congesta	SWB	0.3	4.4	2.0	0.005	0.024	0.012	167		70
P. dulcis	SWB	0.3	3.8	1.0	0.004	0.024	0.009	111	base of culm, 2 samples	70
				1.5			0.010	150		
	SWB	0.3	3.5	1.0	0.003	0.024	0.009	111	upper section of culm,	70
				1.4			0.010	140	2 samples	
P. flexuosa	SWB	0.4	3.9	1.6	0.003	0.020	0.010	160		70
P. lithophila	SWB	1.1	1.8	1.4	0.014	0.016	0.015	93		153
P. makinoi	SWB	0.7	4.0	2.5	0.007	0.029	0.015	167		153
P. meyeri	SWB	0.3	3.7	1.3	0.003	0.027	0.010	130	base of culm	70
	SWB	0.4	4.5	2.0	0.003	0.027	0.009	222	upper section of culm	70
P. nidularia	SWB	0.3	2.9	1.3	0.004	0.016	0.009	144	base of culm	70
	SWB	0.5	4.4	1.6	0.003	0.018	0.009	178	upper section of culm	70
P. nigra cv. henon	SWB	0.3	3.4	1.3	0.003	0.017	0.009	144	base of culm	70
	SWB	0.4	4.4	1.6	0.004	0.015	0.009	167	upper section of culm	70
	SWB	1.5	1.9	1.7	0.016	0.016	0.016	106		153
P. pubescens	SWB	0.2	4.4	1.2-	0.003	0.024	0.009-	119-	base of culm, range of	70
(P. edulis)				1.4			0.010	160	3 samples	
	SWB	0.2	4.4	1.3-	0.003	0.024	0.008-	133-	upper section of culm,	70
				1.4			0.010	164	range of 3 samples	
	SWB	1.3	1.8	1.6	0.012	0.014	0.013	123		153
P. purpurata	SWB	0.2	5.1	1.1-	0.002	0.025	0.008-	133-	range of 8 samples	70
				2.0			0.012	185		
P. rubromarginata	SWB	0.3	5.2	1.8	0.003	0.016	0.009	200	base of culm	70
	SWB	0.4	3.6	1.7	0.003	0.023	0.010	170	upper section of culm	70
P. viridis	SWB	0.4	4.4	1.9	0.005	0.021	0.012	158	base of culm	70
	SWB	0.5	4.7	1.9	0.004	0.024	0.012	158	middle section of culm	70
	SWB	0.3	2.6	1.1	0.005	0.015	0.009	122	upper section of culm	70
P. vivax	SWB	0.3	4.7	1.6	0.004	0.023	0.011	145	base of culm	70
	SWB	0.3	3.5	1.4	0.006	0.015	0.010	140	middle section of culm	70
	SWB	0.2	2.0	1.0	0.008	0.012	0.009	111	upper section of culm	70
Pseudosasa japonica	SWB	0.7	4.0	2.1	0.006	1.028	0.016	131		114
(Sasa japonica)										
Sasa kurilensis	SWB	0.8	6.0	2.9	0.010	0.033	0.017	171		114
	SWB	0.3	3.5	1.3	0.004	0.034	0.014	93		44
Schizostachyum lumampao	SWB	1.2	4.1	2.6	0.005	0.028	0.016	163		135
(Bambusa lumampao)										
Teinostachyum dullooa	SWB	1.0	6.0	3.6						16
(Neohouzeaua dullooa)										

Gramineae: Andropogoneae

Andropogon auctus	SWA	0.3	3.9	1.0-2.0					101
A. dregeanus	SWA	0.3	3.8	1.0-2.0					101
A. semiberbis (A. hirtiflorus var. semiberbis)	SWA	0.4	1.2	0.6-0.7					101
Cymbopogon nardus var. validus	SWA	0.3	4.7	2.1					97
Dichanthium annulatum (Andropogon comosus)	SWA			1.2					75
Hyparrhenia buchananii (Andropogon buchananii)	SWA	1.0	4.0	1.5-2.5					101
H. filipendula	SWA	0.5	4.2	2.1	0.001	0.025	0.016	131	110
H. glauca	SWA			1.5					39
H. hirta (Cymbopogon hirtus or C. validus)	SWA	0.3	4.9	2.0-3.0					102
H. rufa (Andropogon rufus)	SWA	2.0	3.5		0.010	0.020			75
H. ruprechtii (Cymbopogon ruprechti)	SWA	0.4	3.5	0.8-2.0					102
Imperata cylindrica	SWA	0.5	1.9	0.8	0.009	0.018	0.012	67	133
(I. arundinacea)	SWA	1	3.5	1.8			0.010	180	48
I. exaltata	SWA	0.6	3.2	1.3			0.012	108	66
	SWA	0.5	1.8	1	0.005	0.021	0.011	91	135
Ischaemum angustifolium	SWA	1	4		0.009	0.016			50
Miscanthus (sinensis or japonicus)	SWA			2			0.015	133	148
Saccharum aegyptiacum	SWA	0.6	4.5	2.0	0.007	0.033	0.020	100	10
S. arundinaceum	SWA	0.8	4.5	2.6	0.012	0.026	0.016	163	133
(S. procerum)	SWA	0.5	5.5	2.3	0.008	0.031	0.018	128	19
S. munja	SWA	0.7	3.8	2.7	0.013	0.030	0.022	123	133
	SWA	0.5	6.5	2.2	0.006	0.025	0.017	129	37
S. narenga	SWA	0.6	2.6	2.0	0.012	0.050	0.025	80	133
S. officinarum	SWA	0.8	2.8	1.7	0.010	0.034	0.020	85	170
	SWA	0.5	3.8	1.4	0.010	0.033	0.018	76	24

S. spontaneum	SWA	0.7	3.1	2.0	0.012	0.025	0.016	125		133
	SWA		3.2	1.5	0.008	0.025	0.015	100		67
Sorghum halepense	SWA	0.5	1.7	0.7-1.1						101
S. vulgare	SWA	1	5	2	0.010	0.040	0.018	111		167
	SWA	3	6		0.010	0.015		200	fine fibers	58
	SWA			5	0.030	0.035		143	coarse fibers	58
	SWA	0.4	6	2.0-2.5	0.006	0.030	0.012	188		121
	SWA	0.3	3	1.3-1.5	0.006	0.030	0.015	93		121
	SWA	0.1	3.3	0.9						117
	SWA	0.2	3.8	1.0	0.003	0.043	0.013	77		33
S. vulgare var. saccharatum	SWA	1	5	2.0-2.5						157
Themeda arundinacea	SWA	0.6	6.8	2.9	0.010	0.035	0.016	181		21
T. cymbaria	SWA	0.5	2.5	1.1	0.009	0.020	0.014	79		17
T. forskallii var. mollissima	SWA	0.8	3.8	1.5-2.0						102
T. gigantea (Anthistiria gigantea ssp. arundinacea)	SWA	0.7	4.7	2.9	0.014	0.035	0.022	132		133
Trachypogon plumosus (T. polymorphus)	SWA	0.4	2.9	1.0-2.0						102
Vetiveria zizanioides	SWA	0.4	3.5	1.2	0.004	0.028	0.009	133		22
(Andropogon muricatus,	LW	1.5	2		0.010	0.015		150		48
A. squarrosus)	SWA	1.5	2.0	1.8	0.010	0.015	0.012	150		155
Vossia procera	SWA	0.5	5.6	1.6	0.005	0.025	0.013	123		45
(V. cuspidata)	SWA			1.3			0.009	144		32
Gramineae: Agrostideae										
Ammophila arenaria	SWA			0.7						3
Aristida burkei	SWA	0.1	2.5	0.9						91
Muhlenbergia macroura (Epicampes macroura)	SWA	0.5	3.0	1.7	0.005	0.013	0.009	189		27
Sporobolus pyramidalis	SWA	0.5	4	2	0.005	0.012	0.005-0.006	364		60
Stipa tenacissima	LW	0.5	3.5	1.5	0.007	0.018	0.012	125		164
	LW	0.6	1.6	1.1	0.007	0.014	0.009	122		170

Gramineae: Aveneae										
Avena sativa	SWA	0.6	4.6	1.8						122
	SWA	0.1	1.9	0.6						117
		0.5	1.9	1.2					leaf sheath	122
Tristachya rehmanni	SWA	0.4	2.2	1.0						102
Gramineae: Chlorideae										
Spartina cynosuroides	SWA			2.9						134
S. juncea	SWA			2						134
Gramineae: Festuceae										
Arundo donax	SWA	0.6	2.3	1.5	0.012	0.037	0.017	88		133
	SWA	0.6	5.4		0.020	0.025				129
Eragrostis cynosuroides	SWA	0.6	1.5	0.9	0.010	0.018	0.016	56		133
Phragmites communis (P. vulgaris, Arundo phragmites)	SWA	0.8	3.0	1.7	0.010	0.051	0.019	89		107
	SWA			0.9						117
P. karka	SWA	0.5	2.9	2.0	0.010	0.026	0.015	133		133
	SWA	0.5	3.2	1.2	0.007	0.020	0.012	100		23
Gramineae: Hordeae										
Hordeum vulgare	SWA	0.3	1.5	0.9						122
		0.5	1.7	1.0					leaf sheath	122
Secale cereale	SWA	0.7	3.3	1.8						122
		0.6	3.9	1.3					leaf sheath	122
	SWA	0.1	2.3	0.7						117
	SWA	0.5	1.9		0.010	0.025		45-76		125
Triticum aestivum (T. sativum)	SWA	0.7	2.4	1.6						122
	SWA	0.1	3.3	0.7						117
		0.5	1.7	1.2					leaf sheath	122
	SWA	0.4	4.1	1.3	0.008	0.038	0.019	68		136

Gramineae: Oryzeae									
Lygeum spartum	SWA	1.3	4.5	2.5	0.012	0.020	0.015	167	164
Oryza sativa	SWA	0.7	3.5	1.5	0.005	0.014	0.009	167	170
	SWA			0.9				300	136
Gramineae: Paniceae									
Panicum obscurans	SWA	0.3	2.3	0.9-1.6					102
Pennisetum purpureum	SWA	1.3	3.6	2.0					94
Setaria italica	SWA	0.2	2.4		0.006	0.035			128
Gramineae: Phalarideae									
Phalaris arundinacea	SWA	0.7	3.3	2.0	0.005	0.033	0.014	143	110
Gramineae: Tripsaceae									
Zea mays	SWA	0.5	2.9	1.5	0.014	0.024	0.018	83	170
	SWA	0.1	1.9	0.7					117
Iridaceae									
Moraea tricuspis	LF	0.4	1.6	0.7					77
Juncaceae									
Prionium palmita	SWA	0.5	2.0	1.0					118
Xerotes longifolia	SWA	1.0	3.2	2.0	0.005	0.020	0.012	167	107
Liliaceae									
Aloe vera (A. perfoliata)	LF	1.3	3.7		0.015	0.024			172
A. zebrina (A. lugardiana)	LF	0.8	3.6	1.8					96

Cordyline australis	LF	0.8	8.1	3.3					93
C. australis var. veitchii	LF	1.5	2.5						76
C. banksii	LF	1.6	2.4						76
C. baueri	LF	1.3	1.5						76
C. cookii	LF	1.3	7.1						76
C. stricta	LF			2					76
Dracaena draco	LF	0.4	2.6	1.4					77
Kniphofia aurea	LF	1.5	2.4						76
K. recurvata	LF			1.8					76
K. rooperi	LF	1.5	4.6						76
Phormium tenax	LF	3.9	15	9	0.007	0.028	0.016	563	170
Sansevieria cylindrica	LF	3	6.5	4.7					79
S. ehrenbergii	LF	1.3	5.1		0.025	0.040			84
S. guineensis	LF	1.5	5.1		0.020	0.035			84
S. latifolia	LF		8	5				200	164
S. volkensii	LF	0.8	3.1		0.020	0.030			84
S. zeylanica	LF	1.5	6	3	0.015	0.026	0.020	150	164
Scilla rigidifolia	LW	0.8	1.6	1.0					96
Xanthorrhoea sp.	SWA	2	5	3.4					53
Yucca aloifolia	LF	1.2	5.2	1.3	0.007	0.014			29
Y. filamentosa	LF	0.5	3	1.0-1.3	0.006	0.019	0.008-0.011	121	77 144
Y. flexilis	LF	1.6	3.6						76
Y. glauca (Y. angustifolia)	LF	1.6	4.7		0.011	0.014			29
Y. gloriosa	LF	0.5	6	3.5-4.0	0.007	0.020	0.010-0.011	357	13
Y. karlsruhensis	LF	0.5	4.5	1.5-2.5	0.006	0.022	0.011-0.014	160	144
Marantaceae									
Maranta arundinacea	SWA			1	0.007	0.015			131

Musaceae									
Heliconia sp.	LF	3	9	5	0.013	0.028	0.018	278	109
Musa ensete	LF	0.5	5	2.3-2.5	0.007	0.026	0.018	133	119
	LF	2.6	5.9	3.8					81
M. livingstoniana	LF	1.4	6.0						88
M. malaccensis	LF	0.9	5.7	3.6			0.027	133	24A
M. paradisiaca (M. sapientum var. paradisiaca)	LF			3.9-6.9			0.016-0.032	163-363	63
	LF	4.2	7.3	5.5	0.018	0.026	0.020	275	135
M. paradisiaca var. likiuensis (M. sapientum var. likiuensis)	LF	2.7	6.4	3.0-5.5	0.018	0.031			138
M. paradisiaca var. sapientum (M. sapientum)	LF	2.3	6.3	4.5			0.022	205	24A
M. textilis (M. mindanensis)	LF	2.5	6.0	4.0		0.021	0.017	235	135
	LF	2.5	12.0	6	0.007	0.040	0.018	333	170
M. ulugurensis	LF	2.2	4.7	3.1					81
M. violascens	LF	2.5	6.3	4.4			0.025	176	24A
Ravenala madagascariensis	LF		6.0	3.0-3.5		0.030	0.015-0.020	186	165
	LF	2	3	-6.0	0.015	0.020			169
	SWA	1	2	1.3	0.060	0.080			169
Naiadaceae									
Posidonia australis	SWA	0.8	1.3		0.020	0.076			77
Zostera marina	SWA			3.0			0.006	500	120
Palmae									
Acrocomia sclerocarpa	LP	1	3						76
A. totai	LF			2.1					160

Astrocaryum sp.	LF	1.4	2.6	2.0	0.013	0.027	0.018	111		141
Borassus flabellifer	LF	0.5	5.5	4.2	0.030	0.040	0.035	120		55
	LP	3.0	3.6	3.0	0.030	0.040	0.035	86		55
Chamaerops humilis	LF	1.0	3.0	2.0	0.010	0.013		167		165
	LF			1.5			0.010	150		150
Corypha laevis	LW	0.4	1.8	1.4			0.010	140		62
C. umbraculifera	LP	1.1	2.8	2.1	0.010	0.015	0.013	162		135
Elaeis guineensis	LF	1.5	3.5	2.5	0.010	0.013	0.011	227		164
Hyphaene crinita	LW	0.4	5.0	2.1	0.010	0.022	0.015	140		146
H. schatan	LP	0.5	2.0	1.4	0.010	0.020	0.015	93		61
	LW	2.0	2.5	2.3	0.015	0.030				61
H. thebaica	LP	0.5	3.6	2.1	0.013	0.015		150		119
	LW	0.8	2	1.5	0.010	0.025	0.015	100		59
Medemia nobilis	LP	0.8	2.5	1.7	0.010	0.020	0.015	113		61
	LW	0.5	2.3	1.5	0.010	0.020	0.015	100	lamina only	61
Mauritia flexuosa	LF	1	3	1.5	0.010	0.016	0.012	130		164
Nannorhops ritchieana	LF	1.1	2.5							85
Nipa fruticans	LP	0.7	2.5	1.4						91
	LW	0.3	2.3	0.9						96
Phoenix dactylifera	LP	2	6	3	0.016	0.024	0.020	150		164
Raphia taedigera	LF	1.5	3	2.5	0.012	0.020	0.016	156		164
R. vinifera	LF	1.5	2.5							1
Trithrinax campestris	LW	0.7	2.5		0.008	0.020		100		46
Pandanaceae										
Pandanus fasicularis (P. odoratissimus)	LF	1.0	4.2				0.020			172
Restionaceae										
Ecdeiocloea monostachya	SWA	2.0	5.4							99
Typhaceae										
Typha angustifolia	SWA	0.6	1.7	0.9	0.005	0.012	0.009	100		13
	SWA			1.5			0.025	60		130

T. angustifolia var. brownii	LW	0.6	3.0	1.4	0.005	0.018	0.008	175	107
T. domingensis	SWA	1	4.6		0.030	0.055			165
T. latifolia	LW	0.8	4.6	2.1	0.005	0.025	0.011	191	110
Zingiberaceae									
Alpina speciosa (A. nutans)	SWA	0.6	6.2	2.6	0.005	0.051	0.016	163	106
Amomum granum-paradisi	SWA	0.5	2.5	1.1					104
A. hemisphericum	SWA			2.5					2
Costus afer	SWA	0.5	2.8	1.5					104
Hedychium coronarium	SWA			2.6			0.083	31	2
				Dicotyledoneae					
Annonaceae									
Annona reticulata	SBB	1	2						34
Apocynaceae									
Apocynum cannabinum	SBA	18	30		0.008	0.071		570-790	52
Pachypodium rutenbergianum	SBB	30	80	50	0.025	0.060	0.035	1429	68
Asclepiadaceae									
Asclepias curassavica	SBA	10.0	30.0	20.5	0.020	0.044			173
A. fruticosa	SBB	17.8	30.5	22.9	0.010	0.025	0.015	1527	77
A. incarnata	SBA	17.8	58.4	30.5	0.012	0.035	0.020	1525	108
	SC			0.5					42
A. semilunata	SBA	20	27						83
A. sullivantii	SBA	15	25		0.008	0.079		632-1055	52
A. syriaca	SBA			10-30			0.012-0.020	833-1500	136

A. syriaca	SC			0.5					42
A. verticillata	SBA	5	12		0.008	0.040		316-1519	52
Calotropis gigantea	SBB	7.0	30.0		0.018	0.025			172
C. procera	SBB	10	30						95
Cryptostegia grandiflora	SBB	2.5	40	15-20	0.020	0.162			145
C. madagascariensis	SBB	20	40		0.020	0.025			165
Gonolobus laevis	SBA	9	17		0.004	0.032		570-1013	52
Kanahia laniflora	SBB	15	25		0.020	0.030			30
Leptadenia sp.	SBA	12.7	45.7			0.041			77
Marsdenia tenacissima	SBB	5	20						34
Securidaca longepedunculata	SBB	15.2	38.1	22.9					89
Bombacaceae									
Adansonia digitata	SBB	3.5	5.3	4.5					88
Ceiba pentandra	SBB	1	2						34
Boraginaceae									
Cordia gerascanthus	SBB			9.0	0.012	0.016	0.015	600	159
C. holstii	SBB	0.4		8.0	0.012	0.016	0.015	533	159
Cactaceae									
Opuntia sp.	SWA	0.9	3.2						118
Celastraceae									
Celastrus orbiculata	SBB	20	70		0.080	0.135			138
C. scandens	SBB			43			0.024	1792	142
Compositae									
Carthamus tinctorius	SWA			0.5			0.019	26	125
Eupatorium odoratum	SWA	0.3	2.3	0.7	0.007	0.030	0.017	41	20
Helianthus annuus	SBA	0.5	1.3	1.0					142
	SWA	0.6	0.8	0.7			0.022	32	43

H. tuberosus	SWA	0.5	1.6	0.8	0.014	0.028	0.020	40	11
Helichrysum sp.	LW	3.4	4.2	3.5					77
Onopordum acanthium	SBA			5.9			0.006	983	142
	SWA	0.1	3.3	0.9					117
Solidago sp.	SBA	0.8	1.3	1.0	0.007	0.017	0.012	83	7
	SC	0.2	0.6	0.4	0.007	0.020	0.014	29	7
	SWA	0.1	1.7	0.5					117
Cruciferae									
Brassica napus var. oleifera	SWA	1.0	3.4		0.016	0.022		64-155	125
Camelina sativa	SWA			0.3			0.011	27	125
Euphorbiaceae									
Manniophyton africanum	SBB	9.2	20.0	14.0	0.015	0.030	0.020	700	100
Ricinus communis	SBA	3.5	9.3	5.5					18
	SC	0.5	1.1	0.8					18
Leguminosae									
Bauhinia vahlii (B. racemosa)	SBB	1.5	4.0		0.008	0.020			172
Brachystegia randii	SBB	1.3	2.6						99
Crotalaria juncea	SBA			5.0			0.022	227	72
	SC			0.8-0.9			0.021-0.026	35-38	72
C. usaramoensis	SBA	2.3	6.9	3.8	0.014	0.042	0.027	141	73
Cytisus scoparius (Genista scoparia, Sarothamnus scoparius)	SBB	2	9	5	0.010	0.025	0.015	333	164
Hardwickia binata	SBB	1	2						34
Lespedeza cuneata	SBA			1.3					28
(L. sericea)	SWA			0.6					28
Lupinus albus	SWA	0.1	2.3	0.6					117
L. angustifolius	SWA	0.1	2.5	0.5					117
L. luteus	SWA	0.1	2.7	0.6					117
Lupinus sp.	SBA			2.0-3.0			0.016-0.020	139	35
Melilotus alba	SBA	5	18	10	0.020	0.036	0.030	333	164

M. officinalis	SWA	0.1	1.7	0.5				117
Parkinsonia aculeata	SBB	1	2					34
Pueraria thunbergiana	SBA			2.0-3.0			0.012 208	127
Sesbania aculeata	SBA	2	4					149
S. grandiflora	SBB	1.8	3.7	2.7	0.008	0.037	0.022 123	126
Glycine soja (Soja max)	SBA	1.0	4.5		0.008	0.055	0.022-0.028	143
Sophora flavescens	SBB	2.1	4.2	3.0			0.039-0.045 71	140
Spartium junceum	SBB	5	16	10			0.020	164
Trifolium pratens	SBA		6.5	3.0-4.5	0.012	0.025		50
Vigna sinensis var. textilis	SBA	1.1	8.7	4	0.011	0.066	0.030 133	54
Wisteria sinensis (W. chinensis)	SBB	1.3	3.7		0.010	0.020		138
Linaceae								
Linum usitatissimum	SBA	4	66	25	0.007	0.037	0.016 1563	170
	SC	0.1	0.4	0.2	0.010	0.039	0.019 11	112
Malvaceae								
Abutilon asiaticum	SBA	1	4					82
A. avicennae	SBA	1	2.1		0.008	0.037		138
A. bedfordianum	SBA	2	3.7					76
A. graveolens	SBA	1	3.5					82
(A. tortuosum)	SC	0.5	1.3	0.9				104
A. indicum	SBA	1.1	1.8	1.3	0.010	0.015		13
	SBA			1.9			0.015 127	15
Althaea officinalis	SBA			2.5			0.007-0.010 294	14
	SWA			0.5			0.017 29	125
A. rosea	SWA			0.6			0.019 32	125
Gossypium herbaceum	SBA	1.5	3	2			0.018-0.020 105	69
	SC			0.8			0.012 67	69

Gossypium sp.	SBA	0.7	4.2	1.9	0.010	0.028	0.020	95	111
Hibiscus abelmoschus	SBA	2.5	4.5						76
H. cannabinus	SBA	2	6	5	0.014	0.033	0.021	238	164
	SBA	1.5	2.8	2.0	0.001	0.030	0.020-0.021	93	73
H. elatus	SBB	1	1.5						34
H. esculentus	SBA	1.5	8.8	3.7	0.012	0.032	0.020	185	26
	SBA			8.3	0.012	0.027	0.015-0.023	436	171
	SBA			1.8			0.017	106	15
H. floccosus	SBB	2.5	3.6	3.2		0.031	0.026	123	25
H. grandiflorus	SBA			8.8	0.012	0.023			171
H. heterophyllus	SBB	2.5	4.0						76
H. lasiocarpus	SBA	2.1	3.1						86
H. macrophyllus	SBB	1.8	4.5	3.3		0.029	0.026	127	25
H. mutabilis	SBB	1.5	2.4						76
H. quinquelobus	SBB	1.0	3.2						86
H. rosa-sinensis	SBB			6	0.005	0.012	0.006-0.008	857	171
	SBB			1.2			0.012	100	15
H. sabdariffa	SBA	1.2	3.3	1.9	0.010	0.032	0.020	95	126
H. syriacus	SBB	0.6	1.7		0.012	0.035			138
	SBB	2.5	5.4	3.2			0.015	213	13
H. tetraphyllus	SBA	1.0	1.6		0.008	0.020	0.016		120
	SBA			1.6			0.013	123	15
H. tiliaceus	SBB	0.6	2.3	1.5-2.0	0.010	0.018	0.014	125	161
	SBB			7	0.007	0.015	0.008-0.013	667	171
Kydia calycina	SBB	1.0	2.0		0.017	0.024			172
Lavatera arborea	SBA	1	1.5						76
L. maritima	SBA	2.4	3.4						76
Malachra capitata	SBA	1.6	4.5	2.8	0.007	0.029	0.015	187	126
	SBA			2.1			0.016	31	15
M. fasciata	SBA	1.2	5.1	2.0	0.006	0.042	0.016	125	126
Malva sp.	SBA	11.3	29.1	17.0	0.009	0.022	0.015	1133	142
(M. castilla)	SBA	0.8	6	2					162
Pavonia urens	SBB	1.3	6.2	2.3	0.012	0.030	0.019	121	40
P. zeylanica	SBA	1	1.5						34
Plagianthus betulinus	SBB	1.5	2						76

P. pulchellus	SBB			2.0					76
Sida arborea	SBB	1.5	4.3	3.0	0.012	0.028	0.017	176	120
S. carpinifolia	SBB	1.5	2.5						76
(S. acuta)	SBB			1.4			0.013	108	15
S. cordifolia	SBA	1.5	3						76
S. mollis	SBA	1	1.5						76
S. rhombifolia	SBA			1.5			0.010	150	15
Sphaeralcea umbellata	SBA	2.5	4.0						76
Thespesia lampas	SBB			1.9			0.018-0.020	100	36
T. macrophylla	SBB	0.9	4.7		0.012	0.021	0.016		172
T. populnea	SBB	5.2	8	6.9	0.020	0.030			13
Urena lobata	SBA	1.5	5.1	2.3					96
	SBA	0.9	2.5	1.4	0.009	0.027	0.013	108	126
	SBA			1.7			0.013	131	15
Wissandula rostrata (Abutilon periplocifolium)	SBB	1.8	3						78
Meliaceae									
Melia azadirachta	SBB	1	2						34
Moraceae									
Artocarpus kunstleri	SBB	9	27	18		0.044	0.033	545	25
Broussonetia kazinoki	SBB	1.5	10		0.010	0.034			138
B. papyrifera	SBB	6	25	15			0.025-0.030	545	120
Cannabis sativa	SBA	5	55	20	0.007	0.050	0.022	909	170
	SC			0.7					38
Ficus bengalensis	SBB	1	3						34
Humulus lupulus	SBA	4	19	10	0.012	0.018	0.016	625	164
Morus alba	SBB	7	32	16			0.025	640 primary fibers	139
	SBB	2.7	5.1	4.3			0.025	172 secondary fibers	139
Papaveraceae									
Papaver somniferum	SWA			1.5			0.028	54	125

Polygalaceae								
Polygala butyracea	SBA	15.2	33.0					92
Securidaca longepedunculata	SBB	15	47	23				77
Polygonaceae								
Polygonum cuspidatum	SWA	0.1	3.9	1.1				117
Pontederiaceae								
Eichornia crassipes	LW	2	3		0.012	0.030		168
Salicaceae								
Salix viminalis	SBB			1.0			0.012 83	152
Salix sp.	SBB			3				124
Solanaceae								
Nicotiana tabacum	SC	0.7	0.8				0.035 21	6
	SWA	0.1	3.1	0.8				117
Solanum tuberosum	SBA	2.0	45.1	15.9			0.025 796	71
Sterculiaceae								
Abroma augusta	SBA	4.0	6.4					82
	SBA	1.4	4.2	2.2	0.006	0.039	0.017 129	126
Firmania platanifolia	SBB	1.5	3.0		0.015	0.020		138
Guazuma tomentosa	SBB	1.0	2.0					34
Helicteres isora	SBB			1.3			0.013 100	123
	SBB			1.0			0.010 100	15
Kleinhovia hospita	SBB	0.9	2.4	1.5	0.008	0.031	0.015 100	126
Melochia corchorifolia	SBA			1.1			0.011 100	15
M. umbellata	SBB	1.1	3.1	2.0	0.011	0.027	0.016 125	126
Sterculia acerifolia	SBB	2.5	3.5					76
S. diversifolia	SBB	0.5	1.5					76
S. villosa	SBB	1.5	3.6		0.017	0.025	0.020	172
Thymelaeaceae								
Daphne mezereum	SBB	2.0	3.5	2.9	0.010	0.018	0.012 242	120
D. pseudo-mezereum	SBB	1.3	6.2		0.010	0.025		138

Daphnopsis brasiliensis	SBB	0.9	3.7	2.0-3.0				161
	SBB			8	0.015	0.025		74
Edgeworthia papyrifera	SBB	2.4	3.6	2.9	0.012	0.027	0.018	161 170
	SBB		5	3.0-4.0	0.012	0.016		250 165
Lagetta funifera	SBB			5			0.012-0.014	385 120
L. lintearia	SBB	3	6	5			0.010	500 164
Lasiosiphon eriocephalus	SBB	0.4	5.1		0.008	0.029		172
Rhamnoneuron balansae	SBB	2.6	5.3	4.5	0.006	0.024	0.015	300 65
Thymelaea microphylla	SBB	5	8		0.012	0.013		137
Wikstroemia ovata	SBB	1.7	4.2	3.0	0.003	0.021	0.012	250 126
W. sikokianum	SBB	2.5	5.3		0.010	0.030		138
Tiliaceae								
Corchorus acutangulus	SBA			1.0			0.011	91 15
C. capsularis	SBA	1.5	5	2	0.010	0.025	0.020	100 170
	SC			0.8			0.025	31 116
C. olitorius	SBA	1.0	5.3	2.6	0.010	0.025	0.017	153 8
	SBA			1.5			0.016	94 15
Columbia serratifolia	SBB	0.9	2.5	1.6	0.005	0.027	0.014	114 126
Grewia asiatica	SBB			0.9			0.011	82 15
G. multiflora	SBB	1.1	2.7	1.8	0.006	0.024	0.015	120 126
G. occidentalis	SBB			1.6				76
G. oppositifolia	SBB	1	1.5					34
G. tiliaefolia	SBB			1.4			0.013	108 15
Honckenya ficifolia	SBB	1.4	3.0	2.1				90
Sparmannia africana	SBB			3.3				76
Tilia europaea	SBB	1.3	5	2	0.014	0.020	0.016	125 164
T. japonica	SBB	1.5	2.4		0.017	0.023		138
Triumfetta bartramia	SBA	1.1	2.8	2.0	0.009	0.027	0.016	125 126
T. pilosa	SBA			1.5			0.011	136 15
T. rhomboidea	SBB	2.0	2.8					80
T. semitriloba (T. cordifolia)	SBB			2.2	0.015	0.018		64
Ulmaceae								
Holoptelea integrifolia	SBB	0.9	2.1		0.009	0.014	0.012	172

Trema orientalis	SBB			4.0			0.021	190		172
Ulmus montana var. laciniata	SBB	1.5	7.5		0.010	0.020				138
Urticaceae										
Boehmeria nivea	SBA	60	250	120	0.011	0.080	0.050	2400		170
B. nivea var. tenacissima	SBA		250	40			0.055	727		47
B. platyphylla	SBB	30	60		0.002	0.030	0.014		fibers of two types	115
	SBB			27			0.008	3375		115
Girardinia heterophylla	SBA	150	500							77
Laportea crenulata	SBB	8	16							34
Pipturus arborescens	SBB	3.8	6.0	5.1	0.042	0.100	0.069	74		126
Pouzolzia andongensis	SBA	10	20		0.016	0.030	0.022		fibers of two types	115
					0.002	0.018	0.013			
P. hypoleuca	SBA	6	26	11	0.023	0.040	0.030	367		31
Urera cordifolia	SBB	165	175		0.040	0.090	0.070		fibers of two types	115
							0.030			
Urtica dioica	SBB	4	55	25-30	0.020	0.070	0.050	550		164
U. thunbergiana	SBA	5	60		0.020	0.063				138
U. urens	SBA			25			0.040	625		47
Villebrunia integrifolia	SBB	40								76
Vitaceae										
Vitis coignetiae	SBB	1	3		0.025	0.030			primary bast	138
	SBB	0.4	1		0.010	0.025			secondary bast	138

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